

CHAPTER 2

BASIN DESCRIPTION AND INVENTORY

Lake Okeechobee is a large, shallow eutrophic lake located in south-central Florida and is a major feature of the KOE system. With a surface area of km^2 (730 square miles), it is the second largest freshwater lake within the contiguous United States, second only to Lake Michigan. Although it has an average depth of only 2.7 meters, its maximum storage capacity is 1.05 trillion gallons. This water represents the heart of south Florida's water supply and flood control system. Lake Okeechobee provides drinking water for urban areas, irrigation water for agricultural land, recharge water for aquifers, and is a major source of water for the Everglades.

The lake's drainage basin covers more than 11,914 km^2 (4,600 square miles). Major inflows into the lake include rainfall (47%), the Kissimmee River (25%), and numerous smaller inflows (all 5% or less) from Harney Pond and Indian Prairie basins, Fisheating Creek, and TCNS. Major outflows include evapotranspiration (64%), the Caloosahatchee River to the west (12%), the St. Lucie Canal to the east (4%), and four agricultural canals (Miami, North New River, Hillsboro, and West Palm Beach canals, which drain to the south into the Everglades region (James *et al.* 1995). An extensive network of hydrologic and meteorologic monitoring sites exists for the basin, that provides data for flood control, water supply and water quality (Appendix B).

A. BOUNDARIES AND SUBBASINS

The Lake Okeechobee SWIM Planning Area (Figure 2, in Chapter 1) has been defined as the major basins that are direct tributaries to the lake, including those basins that are hydrologically upstream and/or from which water is presently released or pumped into the lake on a regular basis. Although the SWIM Planning Area generally excludes basins that are hydrologically downstream and act primarily as receiving basins for water supply, the conveyance of flood control discharges and the resulting potential associated environmental impacts, make these basins a component of this plan.

Water from several of these basins drains into the lake through the Kissimmee River (C-38), including the S-65 series of basins, S-84, and S-154 basins. The S-133 basin also drains into the lake from the north. The S-133 basin also drains into the lake from the north. The TCNS Basin and the S-135 drain into the lake from the northeast. From the northwest, Arbuckle Creek and Istokpoga Basins, C-41, S-65E, C-40, S-84, L-48, L-49 and S-131 basins drain into the lake. Water from the S-135 and C-44 basins drain into the lake through the St. Lucie Canal when lake stage permits. Basins which drain from the EAA into the lake include the S-4 and Chapter 298 Special Drainage Districts (East Beach Water Control District, East Shore

Drainage District, South Shore Drainage District, the Industrial Canal, South Florida Conservancy [S-236], and 715 Farms).

Additionally, water from the S-2 and S-3 basins is pumped into the lake ("backpumping") only during flood or emergency water conditions. The Fisheating Creek Basin drains into the lake from the western shore while the East Caloosahatchee Basin drains into the lake from the west only during extreme conditions (i.e., when the lake level drops to 11.5 ft.). A detailed discussion of these basins, including their associated water quality issues, can be found in the 1989 Interim SWIM Plan (SFWMD 1989), and a detailed map can be found in Chapter 3 of this plan.

B. KISSIMMEE RIVER RESTORATION

Restoration of the Kissimmee River is an essential component of the overall plan to protect and manage the natural resources of the KOE system. The channelization (1960s through 1971) altered the hydrology and physical form of the Lower Kissimmee River Basin, thereby altering the river and floodplain ecosystems. Approximately 40,000 to 50,000 acres of floodplain marsh have disappeared, resulting in the loss of natural values characteristic of these wetlands (Loftin *et al.* 1988). Channelization of the river and subsequent drainage of its adjacent wetlands has significantly impacted land use characteristics and stimulated agricultural development (improved pasture and intensive dairy operations). Degradation of the natural cleansing capabilities of the river's historic oxbow and floodplain marshes, coupled with major changes in land use during the 1960s and 1970s, increased phosphorus loadings into the lake from the lower basin (Lamonds 1975, Federico 1982).

The restoration will recreate floodplain habitat which may be used by more than 320 different fish and wildlife species and enhance the KOE system. The restoration is planned in phases, over a 15-year period, to allow incremental funding of construction and land acquisition. The state and the U.S. Army Corps of Engineers (USACE) have entered into a partnership to implement the Kissimmee River restoration plan and is the local sponsor of this project (50-50 cost share arrangement). The SFWMD and the state have already acquired much of the 85,000 acres required for restoration.

The project includes three major components: (1) backfilling of 22 continuous, linear miles of the C-38 canal and acquisition of the adjacent floodplain. This component includes removing two of the structures along the canal (S65-B and S65-C), degrading levees located in the floodplain, constructing a protection levee across the Istokpoga Canal, and reconstructing approximately 9 miles of river channel; (2) Headwaters Revitalization, where the primary focus is the storage/release of water from the upper basin lakes to the Kissimmee River, including expansion of canals connecting lakes Kissimmee, Hatchineha, and Cypress, improving the structure at

the outlet of Lake Kissimmee (S65) and land acquisition to allow additional water storage capacity in these three lakes plus Tiger Lake; (3) a comprehensive ecological evaluation program, designed to evaluate the success of the project in meeting the established restoration goals, to provide for continuous, scientifically informed fine-tuning of the reconstruction, and adaptive management of the recovering and restored ecosystem.

C. EVERGLADES RESTORATION

The Everglades Protection Area (EPA) includes the Water Conservation areas (WCAs 2A, 2B, 3A, and 3B), the Loxahatchee National Wildlife Refuge, Everglades National Park, and most of Florida Bay (SFWMD 1995a). Restoration efforts are focused on reducing fragmentation of the landscape and loss of short hydroperiod wetlands, re-establishing the timing, distribution, quantity and quality of freshwater inflows, reducing the impact of nutrient enrichment, and controlling exotic plants. The specific goals are outlined in the South Florida Ecosystem Restoration Plan (SFWMD 1995a) and implementation of this effort is described in the Everglades Program Management Plan (SFWMD 1995b).

The Everglades Forever Act (Sec. 373.4592, F.S., 1994) sets into action a plan for restoring a significant portion of the remaining two-million acre Everglades ecosystem through a program of construction projects, research, and regulation. The Act calls on many state and federal agencies to coordinate efforts to carry out the Everglades Program. Most of the work effort will be conducted by the SFWMD, with joint responsibility by the FDEP for more than half the projects. Together, the SFWMD and FDEP have developed project management plans for each of the fifty-four projects that have been identified in the Everglades Program. In addition, the USACE is participating on several of the Everglades Construction Projects. One of these projects, Hydropattern Restoration (HR-4), is directly tied to the Lake Okeechobee regulation schedule (described in Chapter 5).

Legally, the Everglades Forever Act is an amendment to Sec. 373.4592, F.S. that addresses restoration of the remnant Everglades ecosystem. The Florida Bay Emergency Interim Plan is part of a new Sec. 373.4593, F.S. that addresses Florida Bay Restoration. The SFWMD recognizes the importance of the Florida Bay ecosystem and has assigned a separate program management team to administer its needs and prepare a Program Management Plan for publication in the near future.

D. POINT AND NONPOINT POLLUTION SOURCES

The vast majority of nutrient loading to the lake comes from nonpoint sources, with only minor a contribution from point sources in this system. Sections 373.451-373.4595, F.S. and Chapter 62-43, F.A.C. require that SWIM plans include the

identification of point and nonpoint sources of pollution in the planning area. To fulfill this requirement, the related permitted facilities are given: (1) a summary of industrial and domestic wastewater, dairies, Works of the District and surface water permits, as well as waste disposal sites are shown in Table 1; and, (2) a detailed listings are in Appendices C and D.

D.1. Point Sources

Point sources of pollution are defined as discharges to surface and ground waters where discrete measures of water flow and water quality may be taken. In the Lake Okeechobee Planning Area, domestic wastewater treatment and industrial waste facility discharges are considered point sources.

There are currently 69 industrial waste facilities permitted in the Lake Okeechobee Planning Area. The permitted facilities consist mostly of dairy operations and power plants. Most of these facilities use land application (on-site ponds and/or irrigation) for disposal.

There are 121 domestic wastewater treatment facilities permitted by the FDEP in the Lake Okeechobee Planning Area, with approved capacities between 0.005 million gallons/day (mgd) to 3.00 mgd. Most of these facilities use reuse (land application: percolation ponds, drainfields and/or irrigation) for reclaimed water disposal. Three of the facilities use deep well injection for effluent disposal, while one uses a surface water discharge. The Avon Park Correctional Institute in Polk County is the only treatment facility in the planning area classified as a surface water discharge. All facilities are required, at a minimum, to provide secondary level treatment and basic level disinfection prior to disposal into ground water. Disinfection is not required for deep well injection.

Domestic wastewater and industrial waste facilities in the planning area are regulated by the FDEP. However, in Palm Beach County, regulation of domestic wastewater facilities with a capacity less than 0.50 mgd has been delegated to the Palm Beach County Health Unit. In addition to approval by these agencies, surface water discharges also require a National Pollutant Discharge Elimination System (NPDES) permit. This permitting program, previously administered by the U.S. Environmental Protection Agency (USEPA), was delegated to the state in 1995. Surface water discharge permits include water quality-based effluent limits or technical-based effluent limits. Specific effluent limits are based on the presumption that the assimilative capacity of the receiving water is sufficient to handle these additional pollutant loads. Detailed listings of the permitted domestic wastewater and industrial waste facilities, as well as location maps for each, are contained in Appendix D.

Table 1. Permits in the Lake Okeechobee Planning Area.

Permit Type	Permit Agency	Permit Activity	General Description	Information Provided	Total Number
Point Sources Industrial Wastewater	FDEP	<i>Industrial treatment systems</i>	<i>Listing of permitted industrial waste facilities within lake basin</i>	-Facility name -Facility location with lat/long -Rated capacity	69
Domestic Wastewater	FDEP HRS*	<i>Private and municipal wastewater facilities</i>	<i>Listing of permitted domestic wastewater facilities within lake basin</i>	-Facility name -FDEP ID # -Facility location -Rated capacity -Disposal method	121
Dairies	FDEP	Dairy farm BMPs	Listing of those dairy barns that have begun the permitting process	-Number of cows -BMP system specs. -Percent BMPs completed	29
Nonpoint Sources Works of the District Permits	SFWMD	Agricultural, Industrial, Commercial, NPS BMPs	Listing of SWIM Permits within Lake Okeechobee Basin	-Permit number -Location & project size -Location of WQ monitoring sites -Listing of WQ data -Land use -Basin BMPs specs. -Tracking of sites which exceed SWIM P limits	688
Surface Water Management	SFWMD	Storm water management systems	Listing of SFWMD SWIM permits within the lake	-Permit number -Permittee -Location -Receiving body -Type of facilities -Rate of discharge -Project size	470
Waste Disposal Sites	FDEP	Landfills	Listing of waste disposal sites within the basin	-Site name -Location -Status class	16

*Palm Beach County Health and Rehabilitative Service.

D.2. Nonpoint Sources

Nonpoint source pollution is usually associated with land use activities that do not have a single discrete discharge point. These pollution sources are usually delineated into rural and urban. Rural nonpoint sources include storm water runoff and are associated with agricultural activities. Storm water runoff from these activities carries pollutants such as fertilizers, pesticides and other agricultural chemicals. Urban nonpoint sources are also primarily conveyed by storm water and contain pollutants associated with urban land uses. The sources of these pollutants range from those transported by direct precipitation, to pollutants resulting from automobile tire wear and construction activities.

Septic tank proliferation was recognized in the 1993 SWIM Plan as a potential contributor to nutrient loading to Lake Okeechobee. Although the septic systems may be a significant source of bacteria and toxic household chemicals to local canals, the nutrient loads of nitrogen and phosphorus to the lake from septic systems have are low because of direct interaction with the soils which were shown to retained nutrient loads (ESE 1992).

SFWMD supported the development and implementation of the Okeechobee Utility Authority (OUA). The OUA, a \$20 million publicly-funded water and wastewater authority dedicated to the expansion and improvement of the existing utility system in Okeechobee, became fully operational in September of 1995. Under the existing cooperative agreement between the SFWMD and the OUA, a scope of services that identifies all existing septic systems and sewage package plants along the northern rim of Lake Okeechobee, all necessary infrastructure for incorporation into the OUA system, and a plan the elimination of these systems is being developed. This, in addition to a reuse expansion plan, will continue to reduce nutrient loading to Lake Okeechobee and reduce the demand for potable water in a SFWMD-designated critical water supply problem area. On the south end of the lake, South Bay received a federal grant in July, 1996, as part of the United State Department of Agriculture (USDA) Water 2000 initiative. This will support the overhaul of the water treatment facility and increase the capacity and extend sewage lines to the private state prison that is near completion.

In addition, the FDEP's Dairy Rule addresses phosphorus discharged off-site by dairies in the Lake Okeechobee watershed. Dairy Rule permits issued by the FDEP require dairy farmers to follow Best Management Practices (BMPs) and to submit quarterly ground water monitoring data in annual reports. Parameters monitored include total nitrogen, total phosphorus, nitrates and orthophosphate. This is discussed in detail in Chapter 3 (Water Quality) and the FDEP Dairy Rule permits are listed in Appendix C.

E. LAND USE

E.1. Land Use/Land Cover Categories

Periodic land use/land cover mapping is necessary to monitor the rapid changes in land use and associate watershed management approaches that the SFWMD must evaluate. The SFWMD contracts with the U.S. Geological Survey (USGS) to fly National Aerial Photography Program (NAPP) aerial photography (scale 1:40,000). This aerial photography is then interpreted and classified into land use/land cover types. From 1986 to 1988, SFWMD staff performed this task by interpreting the NAPP aerial photography and classifying the existing land use/land cover conditions utilizing the South Florida Land Use and Cover Classification System (SFWMD LUCCS). SFWMD LUCCS is a three-tier hierarchial, alpha-numeric land use/land cover coding system. Level I is the most general classification level; with categories for agriculture, barren land, forested uplands, rangeland, urban, water, wetlands.

Levels II and III are subcategories with increasing levels of detail. Land use data are presented in Appendix E with out change from the previous Lake Okeechobee SWIM Plan Update.

The 1986/1988 land use/land cover data did not provide adequate detail in reference to dairy and beef cattle pasture. For beef cattle pasture, there was inadequate differentiation between improved pasture, unimproved pasture, and range land. Also, in some locations, the land was classified according to the land cover type rather than the agricultural usage. This was a particular problem where unimproved pasture graded into pine flatwoods, and where seasonal wetlands were used as winter pasture and had been converted into semi-improved pasture. The land cover data did not address the detail of dairy management. Since dairy land use strongly affects phosphorus retention and transport, it was necessary to define dairy land use in more detail. A revised land use/land cover update was completed in 1990 for the dairy areas. Additional changes and corrections are currently being completed for the dairy coverage that will be used in modeling updates.

In 1994, the SFWMD initiated (through outside contract) the interpretation of the 1994/95 USGS NAPP aerial photography to classify the existing land use/land cover conditions. In this effort, the land use/land cover conditions will be classified using the FDOT Florida Land Use, Cover and Forms Classification System (FLUCCS) to standardize mapping across the state of Florida. This effort should be completed by early 1998. FLUCCS is a four-tier hierarchial, numeric land use/land cover coding system.

E.2. Land Use Impacts on Water Quality

Impacts on water quality are a direct function intensity of land use. Land use intensity in the Lake Okeechobee watershed has traditionally been low, primarily ranching. Dairies and vegetable crops are the most intensive land uses in the basin, which contribute to the nutrient loading to the lake. The contribution of nutrients, nitrogen and phosphorus, has been related to the imports of these nutrients to the watershed (Boggess *et al.* 1995). These nutrients, primarily phosphorus, have been imported as animal feed and fertilizer to support improved pastures and dairy operations. There is a high correlation between phosphorus imports and phosphorus load to the lake. Wetlands along the flowpath to the lake have been demonstrated to reduce the phosphorus loading (Boggess *et al.* 1995), although many wetlands have been ditched to drain the land for improved pasture, reducing their capacity to retain water and phosphorus.

Urban land uses within the Lake Okeechobee watershed contribute to nonpoint pollution that enters the lake. Storm water from these areas, which cover approximately 10% of the watershed, may contribute dissolved solids, nutrients, and heavy metals (Whalen and Cullum 1988). These materials enter runoff from lawns, impervious areas such as parking lots, and through on-site wastewater disposal systems. The urban contribution of phosphorus to Lake Okeechobee is approximately

3% of the total load, based on over-target values from basins S-127 and S-133 (see Chapter 3), with the balance from agricultural sources.

Storm water and shallow ground water from agricultural land use may contain pollutants associated with the application of fertilizers, pesticides, and herbicides. Areas north of the lake are used for dairy and cattle farming, whereas areas south of the lake are used for sugar cane, rice, winter vegetables, and sod farming. The major concern is the large amounts of primary nutrients (phosphorus and nitrogen) that are discharged to the lake as surface water runoff from these areas. Although trace amounts of organics and trace elements have been detected within the basin (Pfeuffer 1985; 1988), recently completed studies (see Chapter 3) indicate no major problems exist in the watershed or in the lake itself.

F. AGENCY JURISDICTIONS AND INSTITUTIONAL AUTHORIZATIONS

These agencies operate at federal, state, regional, and local levels and a detailed listing of persons to contact is provided in Appendix G.

F.1. Federal

Federal jurisdiction on Lake Okeechobee involves the regulatory responsibilities of the USACE, the USEPA, and the U.S. Fish and Wildlife Service (USFWS). The USACE is responsible for prescribing the operational criteria and regulation schedules for the Central and Southern Florida Flood Control Project (C&SF Project). Their primary regulatory functions include operation and maintenance of the levee and major outlet works, dredge and fill activities, maintaining navigable U.S. waters, cleanup of pollution spills and the protection of endangered species. In addition, the entire C&SF Project is under review by the USACE. The feasibility phase of the C&SF Comprehensive Review Study (Restudy) began in 1995. The purpose of the study is to reexamine the C&SF Project to determine the feasibility of modifications to the project for improving the quality of the environment, while continuing to provide for other water resources needs such as water supply and flood protection. The lead agencies in the effort are the USACE and the SFWMD. A multi-disciplinary, multi-agency team has been selected to conduct and manage the various projects for the effort, the South Florida Ecosystem Restoration Task Force. The projects associated with Lake Okeechobee and the majority of its watershed are part of the Greater Lake Okeechobee Project Coordination Team, a subordinate group of this task force. The feasibility phase of the Restudy will be accomplished as a series of feasibility studies and will build upon the work from the first part of the study, the reconnaissance phase.

The USEPA is responsible for protection of the environmental resources of Lake Okeechobee. The agency has the legal authority to protect the lake by: (1) prohibiting or restricting discharges of dredged or fill materials in the waters of the lake; (2) reviewing FDEP permits for treatment, disposal and storage of hazardous waste; and,

(3) administering the Resources Conservation and Recovery Act, which is important for water quality considerations in the study area. The USFWS is responsible for conserving, protecting, and enhancing the fish and wildlife and their habitats in Lake Okeechobee. Several other federal agencies also contribute to management and data collection in Lake Okeechobee, including the USGS, the U.S. Forest Service and the National Weather Service, USDA, and the Department of the Interior.

F.2. State

Many state agencies are involved with both the management and regulation of activities in Lake Okeechobee. The FDEP and the Florida Game and Fresh Water Fish Commission (FGFWFC) are leading state agencies in the protection and management of the lake. Their jurisdictions include the protection of water quality, wetland resources, fisheries and wildlife resources of Lake Okeechobee. FDEP issues NPDES permits for point source discharges. Other state agencies that have a role in managing the lake include the Florida Department of Health and Rehabilitative Service, Florida Department of Community Affairs (FDCA), Florida Department of Agricultural and Consumer Services (FDACS), and the FDOT. The Governor's Commission for Sustainable South Florida, a multi-agency/multi-user group, also can provide input to issues associated with the lake and its watershed.

F.3. Regional

At the regional level, the SFWMD and four regional planning councils have jurisdiction within the Lake Okeechobee SWIM Planning Area. The SFWMD's authority is to manage and protect the water resources in a 16-county region which includes the Lake Okeechobee SWIM Planning Area. Regional planning council jurisdictions are assigned by county. Palm Beach, St. Lucie, Indian River and Martin counties are within the Treasure Coast Regional Planning Council. The Southwest Florida Regional Planning Council has jurisdiction within Glades and Hendry counties. The Central Florida Regional Planning Council has jurisdiction within Okeechobee and Highlands counties. The East Central Florida Regional Planning Council has jurisdiction within Polk and Osceola counties. Regional planning councils have responsibilities to develop regional comprehensive policy plans for protection of water resources within the Lake Okeechobee SWIM Planning Area, provide assistance to local governments on related issues, and determine impacts of proposed development on the lake and other related resources. The regional planning councils have all adopted regional policy plans which include goals and policies designed to aid in the protection of all surface and ground waters in the region, including Lake Okeechobee and its tributaries. The regional planning councils also provide technical assistance to local governments and evaluate the impacts anticipated from Developments of Regional Impact on regional resources, such as Lake Okeechobee.

F.4. Local

The local governments listed in Table 2 have the authority to control land use in the Lake Okeechobee watershed through their comprehensive plans and land development regulations. Sectors that exist at the local government level include planning, building, zoning and regulatory departments, water and sewer utilities, city and police departments, and soil and water and conservation districts. The various counties and municipalities have developed comprehensive plans that guide the future development and preservation of local resources.

Table 2. Counties and municipalities in the Lake Okeechobee SWIM Planning Area.

<u>County/Municipality</u>	<u>Municipal Pop. (1990)</u>	<u>County</u>	<u>Countywide Pop. (1995)</u>
Glades		Hendry	28,114
Moore Haven	1,432	Highlands	74,507
Hendry		Glades	7,665
Clewiston	6,085	Martin	111,069
Okeechobee		Okeechobee	30,222
Okeechobee	4,943	Osceola	130,771
Palm Beach		Palm Beach	972,093
Pahokee	6,822	Polk	436,701
Belle Glade	16,177	St. Lucie	172,483
South Bay	3,558		